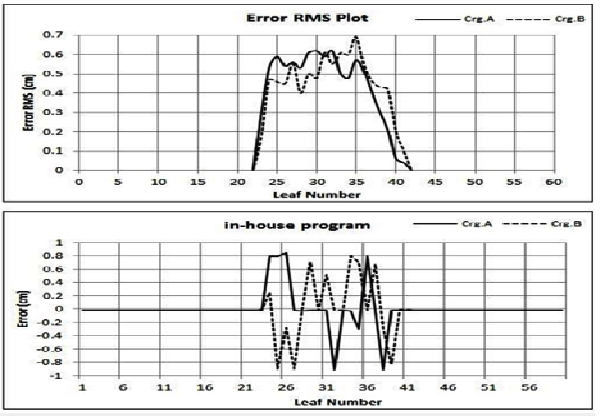

Conclusions: We think our program is able to detect large momentary MLC errors during VMAT delivery even if DFV can't detect these errors. In addition, our program provides many users ease for quality assurance of MLC because our program can visualize the MLC motion during VMAT delivery.

EP-1158

In-phantom measurements of accelerated partial irradiation and arc-therapy for breast cancer

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Purpose/Objective: The aim of this study is to evaluate the performance of the treatment planning algorithm in the determination of dose distributions for non-standard breast cancer treatments (arctherapy and Accelerated Partial Breast Irradiation –APBI-), by means of in-phantom TLD dosimetry.

Materials and Methods: TLD-100 chips were used to determine the absorbed dose at different points in the surface an anthropomorphic female thorax phantom, as well as at the center of the simulated tumor, inside the lung and at the interface between lung (polystyrene foam, ρ_e=0.19 e/cm^3) and tissue (mixture of glycerin and gelatin, ρ_e=1.125 e/cm^3). Dose measurements were compared to the results obtained with the TPS XiO® V4.62 using the FFT convolution algorithm. The APBI treatment included 6 beams of 6 MV, four of which were non-coplanar with a mean field size of about 4x4 cm^2. The arc treatment was performed using 6 beams of 6 MV and one of 15 MV beams, 2 of them were arcs. Both treatments were planned using forward planning.

Results: It was found that tumor dose measurements, for arctherapy exhibited a mean variation of 5% under the TPS values and of 13% for the APBI case. In both treatments the dose at the surface was consistently overestimated by the algorithm, 6% in the arctherapy case and 18% for the APBI treatment. Lung measurements presented larger deviations in both techniques.

Conclusions: Arctherapy measurements, in general, agreed better with the calculated results. This was expected considering the higher complexity of the APBI technique. The relatively large deviations observed for the tumor can be explained by the reduced size of the phantom's breast, which made difficult to locate the detectors under equilibrium conditions and far from high dose gradients. There was a marked trend of TPS overestimation of the dose in tissue interphases, consistent with the absence of epithelitis in patients treated with these techniques.

EP-1159

BELdART-2: a national IMRT audit

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Purpose/Objective: Past incidents in radiotherapy centers both in Belgium and in surrounding countries have shown the need for an extensive quality audit program in radiotherapy. In Belgium these audits were first commissioned by the Federal Agency for Nuclear Control (FANC) and performed as a voluntary national audit (BELdART). It was the first national audit program using L-α-alanine-EMR dosimetry at such large scale. All Belgian radiotherapy departments participated in the BELdART dosimetry audit over a period of 3 years (2009 – 2011). In total 34 centers and 61 linacs were audited and were confirmed to work within optimal levels. At the end of 2012 the College of Medicine - Radiotherapy gave the permission to start with a national mailed audit program involving more complex radiation therapy techniques.

Materials and Methods: All clinical radiation units in Belgium (> 91) will be audited in a period of 4 years using 2 independent dosimetric techniques. The audit is designed for more complex treatment techniques, i.e. IMRT, arc therapy, Tomotherapy, Ciberknife, …. Absolute measurements will be performed using L-α-alanine-EMR dosimetry and EBT3 film dosimetry will be used for the measurement of 2D dose distributions. Irradiations will be performed at the hospital centers and the local physicists will perform both planning and delivery. The 'easy-cube' (sun nuclear) will be used as phantom and custom made slabs preloaded with the alanine pellets and gafchromic films will be inserted for the different steps in the QA protocol to limit the amount of manipulation involved in the process and reduce the user-dependent uncertainty. Beside checks of the treatment delivery in homogeneous and inhomogeneous setting an extra check where the electron density reconstructed by the treatment planning will be compared to the known values of the easy cube.

Results: The first round of auditing for basic conditions have shown that it was possible with alanine to reach an accuracy similar to the golden standard ionization chamber with an uncertainty of 1% (k=1) for doses down to 4 Gy. Preliminary audits will be performed in cooperation with university hospitals in Belgium to assess the realistic achievable quality of IMRT implementation in Belgium.

Conclusions: In view of the development of new techniques of radiation dose delivery that brings new difficulties even at the level of reference dosimetry, auditing programs using completely independent dosimeters are of the utmost importance to insure safe and high quality treatments at the national level.

EP-1160

Absolute dosimetry with EBT2: double channel calibration and empirical crossplane correction.

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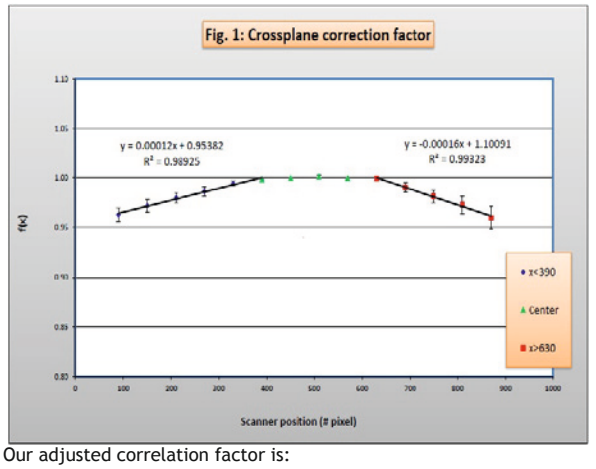
Purpose/Objective: The aim of this work is to present a method; developed in our hospital, that allows using Gafchromic EBT2 films to perform absolute dosimetry.

Materials and Methods: The method consists of two parts: the first one is to perform a dosimetry calibration and the second to apply a correction to remove the transverse dependence of the scanner. Dosimetry calibration is done following the steps outlined in the paper by A. Micke et al.[(1)] concerning the dual channel calibration (DCC) for Gafchromic EBT2 films irradiated at different dose levels ?? in a Siemens ARTISTE linac and digitized in transmission mode 24 hours after irradiation using an Epson Expression 10000XL scanner. Each film is digitized three times placing it in the center of the scanner with landscape orientation and active layer down. In each digital image RGB channels are splitted using ImageJ software. Pixel value (PV) is converted into optical density (OD) for the red (ODr) and blue (ODb) channels. A new image is obtained dividing the ODr image (ODrI) by ODbI. This process is done with an ImageJ plug-in developed by the authors of this work. Dose (D) readings are made with PTW 0.6 cc ionization chamber (IC), placed in a RW3 slabs phantom. Obtaining the average value ODr/ODbin a ROI centered on each image the calibration table {ODr/ODb, D} is generated. Transverse correction is obtained digitizing the pieces of film used in the DCC. Pieces are placed at different lateral positions along the center of the scanner and 112 images are obtained (14 positions x 8 dose levels). Red channel is splitted from each image and a set of 112 readouts is generated getting the PVr from 1x1 cmxcm centered ROI's normalized to that of the center of the scanner. Correction factor, f(x, D) is obtained as a function of the lateral position (x) and D.

Results: It is noted that dose dependence of the correction factor is negligible thus a new factor is calculated based on the average: f (x). Plotting f(x) versus x (# pixel), three differentiated regions are observed (Fig 1).



Our adjusted correlation factor is:

$$f_a(x) = \begin{cases} a_1 \cdot x + b_1; \; x < 390 \\ 1 \; ; \; 390 \leq x \leq 630 \\ a_2 \cdot x + b_2; \; x > 630 \end{cases}$$

To obtain the calibrated image, the PVrI is divided by this factor, converted into ODrI, divided by ODbI and finally DCC is applied.

Conclusions: This method was applied for several beam configurations placing EBT2 films in different phantoms. Dose planes obtained were compared to equivalent measures obtained with PTW 2D-ARRAY seven29 and to calculated data from CMS XiO TPS. PTW Verisoft was used to calculate Gamma2D planes and in all cases the gamma index (3%, 3 mm) was below 1 for at least 95% of points. There is also a good agreement between the absolute doses measured at different points of the film with measurements made with IC. Differences are less than 3%.

REF. (1) A. Micke, D. Lewis and X. Yu, 'Multichannel film dosimetry with nonuniformity correction', Med. Phys. 38(5), 2523-2534, (2011).

EP-1161

3D verification of VMAT treatment plans using electronic portal imaging device

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Purpose/Objective: Pre-treatment verification of radiation plans is an important part of the quality assurance program. None of advanced treatment techniques could be applied without the guarantee that the delivered dose is coincided with the planning dose at a level of the IAEA recommendations. This analysis can be performed by the means of the electronic portal imaging device (EPID). The method of the 3D dosimetric verification of the volumetric-modulated arc therapy (VMAT) plans based on EPID was studied.

Materials and Methods: It was investigated about 50 radiation treatment plans for the SBRT patients with non-small cell lung cancer (NSCLC), pulmonary metastasis, prostate cancer, head-and-neck tumors and brain lesions, which were treated in the Centre for Stereotactic Radiotherapy and Radiosurgery in Novosibirsk Research Institute for Circulation Pathology. During a complete treatment simulation at the linac the portal dose images (PDI) were received for each patient field and compared with the planned PDIs. 3D dosimetric verification was performed for all patient plans calculated according with the volumetric-modulated arc therapy (VMAT). The procedure fulfilled using the IViewGT electronic portal imaging device (EPID) and Dosimetry Check software. The plans were verified by comparison the isodose lines, 2D profiles, dose volume histograms and γ-analysis.

Results: The planned and reconstructed dose distributions showed good agreement for pre-treatment verification of the VMAT plans. The average planned and measured isocentre dose difference was 1.20% (range 0.07–2.56%). 3D γ-analysis revealed γ_{mean}= 0.28 for lung metastasis, 0.32 for lung SBRT, 0.33 for prostate, 0.33 for brain lesions and 0.39 for head-and-neck tumors. The passing criteria for the treatment plans was established for the head-and-neck tumors within $P_{\%}$ = 90% (γ ≤ 1) and within $P_{\%}$ = 95% (γ ≤ 1) for other considered localizations.

Conclusions: Verification method on the base of electronic portal imaging device has been successfully implemented. EPID can be used for the high accuracy, high resolution and fast routine pre-treatment verification of VMAT treatment plans.

EP-1162

Validation of a pre treatment specific patient QA method for Cyberknife

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Purpose/Objective: The purpose of this study was to evaluate an absolute pre-treatment verification method for Cyberknife therapy with a PinPoint ionization chamber and radiochromic EBT3 films.

Materials and Methods: The CT scan of the Easy cube Phantom was acquired with the clinical parameters used for Cyberknife patients; the PinPoint ionization chamber and radiochromic film were positioned in the centre of the phantom. Eight fiducial markers were previously inserted into the phantom for treatment set-up. A fiducial tracking method was used for template QA plan: the patient's plan was recalculated on the Easy Cube phantom and centred in the sensitive volume of the Pin Point ionization chamber. The dose was calculated with Ray-Tracing algorithm. The radiochromic EBT3 films were properly calibrated with a 6 MV linear accelerator (Clinac 600, Varian), delivering dose from 0 Gy to 10 Gy with 12 dose points. A total of 137 patients were evaluated: 91 patients with the PinPoint chamber only and 46 patients with PinPoint chamber and radiochromic film.

Absolute dose measured with the PinPoint chamber was compared with the mean dose calculated in the sensitive volume of the chamber from the treatment planning system. The radiochromic films were scanned using a Epson 1000XL in transmission mode, 48 bit colour and resolution of 72 dpi. For each patient, calculated and measured axial planar dose distribution was compared with the Gamma Analysis Method (3% dose difference and 3 mm distance to agreement criteria) performed by the VeriSoft Program (PTW).

Results: The percentage differences between calculated and measured PinPoint absolute dose ranges from -7.2 to 9.1 with a mean value of 4.8±4.1, resulting to be below 5% in the 73.9% of cases. The percentage of patients passing the gamma analysis (90% of pixels exceeding a 3% and 3 mm threshold) was 84.8%.

Conclusions: The results obtained with PinPoint measurements show a good agreement between calculated and measured absolute dose. Preliminary results obtained with radiochromic films show some critical aspects. Further investigations regarding the possible employment of a 2D-array are required in order to perform the comparison between calculated and measured axial planar dose distribution with the possibility to speed up the procedures of QA program.

EP-1163

In vivo verification of IMRT delivery using a transmission detector, not requiring pre-treatment time on a linac

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Purpose/Objective: The DAVID is an optically-transparent, transmission-style detector composed of two sheets of Perspex enclosing a vented air gap. The gap contains a series of collection wires running in the direction of the MLC leaf movement; each wire is held at a potential and is aligned with an individual MLC leaf pair. The signal generated at each wire is proportional to the radiation fluence through its associated leaf pair; with additional components from adjacent leaf apertures, due to scatter inside the Perspex. The current paradigm for using the DAVID, as an in-vivo device, is to record a DAVID signal during the pre-treatment verification of treatment delivery to a phantom; should the treatment pass the verification, the DAVID signal will be used as a baseline to compare the subsequent in-vivo responses for each treatment fraction. A new procedure has been suggested, where the treatment is verified using independent checking software; if the treatment passes this test, the information held by the independent software is then used to generate a DAVID signal, which can be used as a baseline for the subsequent in-vivo measurements. The independent dose check and generation of a baseline signal for in-vivo measurements provides a safe system that will catch errors in the TPS, plan transfer to the